

AperTO - Archivio Istituzionale Open Access dell'Università di Torino

## Optimism and Overconfidence Biases among Entrepreneurs: a benchmarking-model

### This is the author's manuscript

*Original Citation:*

*Availability:*

This version is available <http://hdl.handle.net/2318/1509045> since 2016-11-10T00:34:04Z

*Publisher:*

Mr. Md. Mahbubul Hoque Bhuiyan, World Business Institute, Australia

*Published version:*

DOI:10.13140/RG.2.1.3288.7207

*Terms of use:*

Open Access

Anyone can freely access the full text of works made available as "Open Access". Works made available under a Creative Commons license can be used according to the terms and conditions of said license. Use of all other works requires consent of the right holder (author or publisher) if not exempted from copyright protection by the applicable law.

(Article begins on next page)

## **Optimism and Overconfidence Biases among Entrepreneurs: A Benchmarking-Model**

Luisa Tibiletti<sup>1</sup> and Mariacristina Uberti<sup>2</sup>

*Optimism and overconfidence are well documented cognitive biases in the entrepreneurship literature (see Shepherd et al., 2015). Although these attitudes are typically thought to be almost overlapped, empirical studies make evidence of their different construct (see Trevelyan, 2008, 2011). In the paper at hand we go a step further in dwelling the descriptive and normative motivations inducing misconfidence biases to arise. First, we introduce the definition of optimism as under-estimation of the task difficulty. Second, we define overconfidence as the tendency to overestimate the probability to achieve an uncertain task. To calculate this probability we set up a prescriptive benchmarking-based model. Third, we spotlight situations in enterprise risk management (ERM) where misconfidence biases in judgment emerge. In the path of Bordley et al. (2014) results, overconfidence arises in presence of: (1) optimism coupled with poor entrepreneurial projects, and (2) pessimism coupled with good entrepreneurial projects. The influence of the escalation and de-escalation of commitment effect biases is also discussed. Our study builds a normative foundation for overconfidence and casts light on which circumstances that occurs. Our results have also practical implications. In fact, it is important for entrepreneurs be aware of situations where self-confidence is normatively biased and so, if necessary, mindfully rethink the assumptions and strategies.*

**JEL Codes:** M20; M12; C91; D81

**Keywords:** Optimism and overconfidence; Benchmarking procedure, Escalation and de-escalation of commitment; Regulatory focus theory; Key Performance Indicators.

### **1. Introduction**

Research in entrepreneurship recognizes that entrepreneurs are individuals generally prone to fail in optimism and overconfidence biases (see Shepherd et al., 2015 for an ample review on entrepreneurial heuristics and biases, and specifically Everett and Fairchild 2014; Engelen et al., 2014; Galasso and Simcoe, 2011; Hmieleski and Baron 2009). The optimism bias refers to entrepreneurs' tendency to underestimate the difficulty of the goal to meet; whereas overconfidence bias refers to the tendency to overestimate the probability of success of the entrepreneurial project at hand. These cognitive biases are typically thought to be positively interdependent and even overlapped. However supported by empirical studies based on online surveys Trevelyan (2008) claims that optimism and overconfidence are distinct constructs with no relevant positive association. Extending this line of inquiry, we delve deeper their differences and explore why entrepreneur rationally engage biased judgements.

First, we give a formal definition of optimism according to the perceived difficulty to achieve the goal. The more the goal is easy-perceived, the higher the agent optimism level; and vice versa for hard-perceived goals. In the path of Bordley et al. (2014) we

---

\* Prof. Luisa Tibiletti. Department of Management, University of Torino, Italy. email: [luisa.tibiletti@unito.it](mailto:luisa.tibiletti@unito.it)

\* Prof. Mariacristina Uberti. Department of Management, University of Torino, Italy. Email: [mariacristina.uberti@unito.it](mailto:mariacristina.uberti@unito.it)

illustrate the link between the easy/hard goal perception and the agent gain-seeking/loss-aversion attitude.

Second, we suggest a probabilistic definition of self-confidence miscalibration based on the gap in evaluation between the entrepreneur and a well-calibrate external expert. To calculate the subjective probability to achieve the goals we use a benchmarking model under risk (see Castagnoli and Li Calzi, 1996; Beccacece and Cillo 2006).

Third, we present the main contribution of the paper. We identify situations in enterprise risk management (ERM) where misconfidence biases in judgments emerge. Following Bordley et al. (2014), we prove that overconfidence arise in connection with: (1) agent's optimism coupled with expected poor entrepreneurial performances, and (2) agent's pessimism coupled with expected good entrepreneurial performances.

In conclusion, we build a theoretical framework that: (1) sets a different definition for optimism and overconfidence biases; (2) provides foundation for overconfidence conform with the prescriptive Expected Utility theory (see von Neumann and Morgenstern, 1947) and the descriptive Prospect Theory (see Kahneman and Tversky, 1979); (3) spotlights circumstances where self-confidence judgement is normatively biased. Our results have also practical implications. In fact, to make mindful evaluations entrepreneurs must be conscious when they are predisposed to fall in misconfidence traps.

The remainder of the paper is organized as follows. In Section 2, we introduce the definitions of optimism and overconfidence. In Section 3 we set up a target-based theoretical model to calculate the probability to achieve the goal. Sufficient conditions for misconfidence in judgement are set out in Section 4. Section 5 concludes the article.

## **2. Optimism and overconfidence biases in the language of probability**

Shepherd et al. (2015) provide an extensive review of the several heuristics and biases documented in the entrepreneurial decision-making process. Among others, overconfidence and optimism are recognized key drivers in contributing on either the firm development and success or the firm failure. Optimists are defined as people who tend "to hold positive expectancies for their future" (see Scheier et al., 1994) and look at the

goals through “rose-tinted glasses” (see the seminal studies of Lichtenstein et al. 1977, 1982). Vice versa, overconfident entrepreneurs are defined as individuals who overestimate the probability of successfully meeting their commitments (see Conine, 2014). Despite a common believe, Trevelyan (2008) has made evidence that no association exists between optimism and overconfidence. To evaluate uncertain projects the entrepreneur has to fix a goal to achieve. However, in real world the commitments are often vague and uncertain. In other words, goals are random variables. It follows that the agent is asked to deliver her personal views in the language of probability.

To explain this point, let start with an example. A manager has to evaluate a project with an uncertain cash flow. The standard guide-lines in the corporate finance literature suggest to check the financial capital sustainability on the basis of measurable *Key Performance Indicators* (see Brealy et al., 2006) as:

1. Return on Equity (*ROE*);
2. Return on Debt (*ROD*);
3. Return on Investment (*ROI*).

Under the assumption of perfect capital market, the Modigliani-Miller formula (see Modigliani and Miller, 1958) relates the profitability indicator *ROE* of a project with the financial leverage ratios as follows:

$$ROE = [ROI + (SPREAD \times DER)](1 - tax)$$

Where

$SPREAD = ROI - ROD$ ,

$DER$  = Debt Equity Ratio or financial leverage

$tax$  = average tax

Specifically, *Modigliani-Miller's formula* pinpoints the key role played by the difference  $SPREAD = ROI - ROD$ . That quantity not only signs the profitability direction of *ROE*, but also emphasizes its value due to its multiplicative effect. A basic condition for financial sustainability of the project is given by:

$$ROI > ROD.$$

If the cash flows of the project are uncertain, *ROI* and *ROD* are uncertain as well. Therefore, above condition needs to be translated in the language of probability. So, instead to check whether above inequality holds, we are asked to calculate:

*the probability that the (uncertain) ROI of the project be higher than the (uncertain) ROD,*

and only if that value is sufficiently high the project will be taken under consideration. In Section 3 we show an operational way to make the probability calculation. But before a definition of optimism is needed.

## **2.1 Optimism: look at commitments through “rose-tinted” glasses**

Intuitively speaking an agent is optimist whether she tends to have a “pinked view” on the commitments. The problem of how an agent calibrates the subjective perception of the task difficulty has been investigated in the last twenty years in the experimental psychology literature see Lichtenstein et al. (1982), Yates (1990) among others. The subjective judgments depend on: (1) the individual cardinal utility capturing the individual risk preferences and (2) the personal “reference point” (see Kahneman and Tversky, 1979). Then two practical questions arise:

Q1.: *How to elicit the individual cardinal utility/value function?*

Q2.: *How to set the appropriate “reference point”?*

Let start to tackle Q1. Let  $u$  a bounded, increasing (but not constant) and continuous cardinal utility function. As seminally discussed by Borch (1968) in the context of ruin probabilities, without loss of generality,  $u$  can be normalized so that  $\inf u(x)=0$  and  $\sup u(x)=1$ . Then  $u$  satisfies all the properties characterizing a cumulative distribution function (c.d.f.). As Berhold (1973, p. 825) states “there are advantages to having the utility function represented by a distribution”, because we can grasp intuitive interpretations. In fact, if  $F$  denote the c.d.f. of the uncertain target  $T$ , then

$$u(x) = P(x \geq T) = F(x) \quad (1)$$

See Berhold (1973, p. 825). Equation (1) states a fundamental equivalence: the c.d.f.  $F$  of the target  $T$  just coincides with the normalized utility function  $u$ . To put it differently, Equation (1) tells us that we can think of the agent cardinal utility  $u(x)$  as the probability that the uncertain target  $T$  is not greater than  $x$ . We conclude that all information about the

agent optimism can be just extrapolated from the perceived shape of the c.d.f. of the target  $T$ .

We are now ready to face Q2. In the last twenty years, this question is became a central one in the experimental and theoretical economics, see Hoffmann et al. (2013).

We have to distinguish between the *objective* and *subjective* reference point:

- *The objective reference point: the median*

In experimental research the most common “reference point” is the *median* of the distribution of possible outcomes; see Heath et al. (1999). Let remind the definition. Given a random target  $T$ , the value  $m$  such that

$$P(T < m) < 0.5 \text{ and } P(T \geq m) \geq 0.5$$

is called a *median* of  $T$ . The median thus defined always exists, and is unique. Alternative definitions are possible, but they yield the same value when the distribution of  $T$  is continuous and unimodal. Hereafter we consider only targets with unimodal distributions.

- *The subjective reference point: the mode*

Let assume the target  $T$  a unimodal<sup>3</sup> random variable with mode  $M$ . As a consequence, the correspondent c.d.f.  $F(x)$  defined on the support  $(a, b)$ , turns out to be an S-shaped c.d.f., that is convex for  $x \in (a, M)$  and concave for  $x \in (M, b)$ . The concavity switching point is in correspondence of the mode  $M$ . To find out the agent perceived reference point we use formula (1). According to Prospect Theory (see Kahneman and Tversky, 1979), the subjective reference point corresponds to the subjectively perceived “knock-out” value that divides the domain of the perceived losses from that of the perceived gains. By (1) the agent utility  $u$  coincides with the c.d.f.  $F$ , so  $u$  is S-shaped with the concavity switching point in correspondence of  $M$ , as well. In conclusion, the *agent reference point* is just *the mode  $M$* .

As discussed in Bordley et al. (2014) the definition of hard-perceived and easy-perceived task is given on basis of the gap between the target most likely value delivered by the agent, i.e. the mode  $M$ ; and that delivered by an external expert, i.e. the median  $m$ .

Intuitively, if the value  $M$  expressed by the agent is lower than that  $m$ , then the agent feels the *target easier* than the external expert does; in such a case the agent is called an

---

<sup>3</sup> If  $T$  is not strictly unimodal, let  $M$  be the midpoint of the modal set.

*optimistic* individual. Vice versa if  $M$  is higher than  $m$ , the agent is called a pessimistic individual. If  $M$  and  $m$  coincide then the agent is called a well-balanced in judgement individual (see Figure 1).

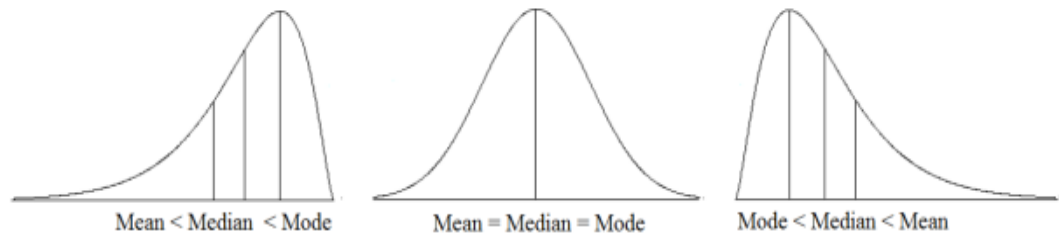


Figura 1 Hard-perceived target, symmetric-perceived target and easy-perceived target.

A simple condition for testing the presence of optimism or pessimism is offered by the so-called van Zwet mean-median-mode inequalities; see van Zwet (1979). Let a unimodal continuous target  $T$  with mean  $\mu$ , median  $m$  and mode  $M$ . Then:

- a) if the agent is pessimist, then  $\mu \leq m \leq M$ ;
- b) if the agent is optimist, then  $M \leq m \leq \mu$ ;
- c) if the agent is well-balanced in judgement, then  $T$  is symmetric and  $\mu = m = M$ .

The alphabetical/counter-alphabetical order among mean, median and mode offers a user-friendly test for optimism/pessimism measuring<sup>4</sup> (see Figure 1).

The intuition behind follows. Optimistic agents perceive the goal as an easy task, and set the *subjective* reference point, i.e. the mode  $M$ , smaller than the *objective* one, i.e. the median  $m$ ; and vice versa pessimistic agents perceive the goal as a hard task and set the subjective reference point, i.e. the mode  $M$ , higher than the objective one, i.e. the median  $m$ . If the agents have symmetric-perceived opinions, the subjective and objective reference point coincides.

Due to the equivalence (1) between the target c.d.f. and the agent utility function, Bordley et al. (2014, Theorem 2.) state the equivalence between the easy/hard target perception and loss aversion/gain seeking attitude. On the loss domain the utility function is convex

<sup>4</sup> Note that van Zwet (1979) inequalities are only necessary conditions for optimism and pessimism, see Abadir (2005) for counterexamples and Bordley et al. (2014) for technical details.

that shows the agent gain seeking attitude, whereas on the gain domain the utility function is concave that exhibits the agent risk aversion (see Figure 2).

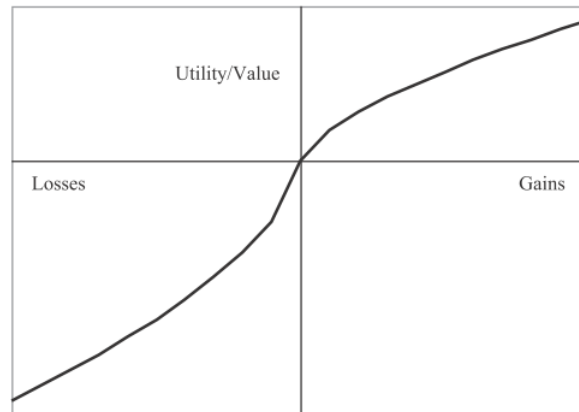


Figure 2. A S-shaped utility/value function

Above is also related with the regulatory focus theory (see Higgins, 1998, Higgins et al., 2001). If individuals have a *promotion focus*, they exhibit risk-seeking attitude and are endowed with a convex utility function. Alternatively, if they have a *prevention focus*, they display risk-aversion and are endowed with a concave utility function.

### **3. Overconfidence: miscalibration of the success probability**

Since the seminal studies of Lichtenstein and Fischhoff (1977) and Kahneman and Tversky (1977, page 5) confidence miscalibration has been documented and studied in social sciences. Moore and Healy (2008) distinguish three different facets of confidence miscalibration: (a) the misconfidence, i.e. a fallacious confidence in own performance; (b) the overplacement or ‘better-than-average’ effect, i.e. the misconfidence in own performance relative to others; and (3) the overprecision, i.e. the tendency to have excessive trust in forecasting future uncertainty. In the following, we focus on (1) the self-misconfidence. We say that an agent gives a “misaligned judgement” when her personal evaluation of the probability of success is misaligned respect to that expressed by the external expert. A crucial point turns out:

*How to measure the probability of meeting the target?*



To achieve this objective, we draw upon the benchmarking procedure.

The benchmarking procedure originally proposed by Castagnoli and LiCalzi (1996) indicates an operational way to calculate the probability that an (uncertain) project  $X$  overcomes the (uncertain) target  $T$ . This prescriptive target-based model satisfies von Neumann and Morgenstern (1947)'s and Savage (1954)'s axiomatization through a probabilistic and intuitive interpretation of the expected utility of a lottery  $X$ . Bordley and LiCalzi (2000) prove that the expected utility of a lottery  $X$  can be read as the probability that  $X$  outperforms a stochastically *independent* target  $T$  with c.d.f.  $u$ , i.e.

$$P(X \geq T) = E(u(X)) \quad (2)$$

where  $E(.)$  is the expectation operator. This interpretation shows the key advantage in using the benchmark-procedure: the subjective beliefs about the probability of successfully meeting the target coincides with the expected utility of  $X$ . In conclusion all we need to calculate (2): (a) the perceived c.d.f. of the uncertain target index  $T$  (corresponding to  $ROD$  in the example in Sec. 2); and (b) the c.d.f. of the uncertain financial index  $X$  of the project (corresponding to  $ROI$  in the example in Sec. 2).

#### **4. When does misconfidence occur?**

Using Bordley et al. (2014, Theorem 3) sufficient conditions for misconfidence biases can be stated. For explanatory purposes, we word them in the frame of the example described in Sec. 2.

Let  $ROD$  an uncertain target with median  $m$ . Suppose that an external expert declares equal to  $m$  the most likely value for  $ROD$ . Let  $ROI$  is the financial index chosen to measure the financial attractiveness of the uncertain project at hand. Let  $ROI$  is independent of  $ROD$ . Then if the agent perceives that:

- a) *the most likely value for  $ROD$  is smaller than  $m$  (i.e. she faces an easy-perceived target) and the support of  $ROI$  belongs to  $(-\infty, m]$ , i.e. the expectancies on the financial project outcomes are very bad, or*
- b) *the most likely value for  $ROD$  is greater than  $m$  (i.e. she faces a hard-perceived target) and the support of  $ROI$  belongs to  $[m, +\infty)$ , i.e. the expectancies on the financial project outcomes are very good,*

then the agent exhibits **overconfidence** on the probability that  $ROI > ROD$ . And vice versa, if the agent perceives that:

- c)  $ROD$  is greater than  $m$  (i.e. she faces a hard-perceived target) and the support of  $ROI$  belongs to  $(-\infty, m]$ , i.e. the expectancies on the financial project outcomes are very bad, or
- d)  $ROD$  is smaller than  $m$  (i.e. she faces an easy-perceived target) and the support of  $ROI$  belongs to  $[m, +\infty)$ , i.e. the expectancies on the financial project outcomes are very good,

then the agent exhibits **underconfidence** on the probability that  $ROI > ROD$ .

Immediate evidences turn out. The optimism attitude and the overconfidence bias are distinct constructs. That is consistent with Trevelyan (2008, 2011) empirical studies, where the association sign between these two biases is not clear. The very gears in moving towards over/under confidence are: (1) the expected performances of the uncertain project measured by  $ROI$  as in the example in Sec. 2; (2) the attitude of believing in having to face an easy/hard task. In experimental psychology, conditions a) to d) are related to cognitive biases as follows:

a) Overconfidence in handling with very-poor projects is commonly associated with the “*escalation of commitment effect*” (see the seminal studies of Staw, 1976). That is also referred to the “*sunk cost fallacy*” that is the misleading behavior that guide managers to invest resources into failing businesses. This bias is also set in relation with the “*hot-hand fallacy*” (also known as the “*hot hand phenomenon*” or “*hot hand*”). That is the false belief that an entrepreneur who has once experienced success has a greater chance of further success in the future, although the project at hand displays realistic poor expectancies. These circumstances correspond to case a).

b) Dealing with hard-perceived tasks coupled with very good expectancies on the outcomes (see case b)) may drive ambitious managers to be overconfident. That is

commonly explained as an effect of the “*desirability bias*” that influences the evaluation of desired event occurrence (see e.g. Giardini et al., 2008).

c) When pessimism in evaluating the target difficulty is associated to poor expectancies on the project outcomes, a loss averse entrepreneur tends to be underconfident in successfully meeting the target (see case c)). That tendency may be explained by the influence of “*pessimism bias*” that induces the “*status quo effect*”. That is related also with the loss and gain asymmetry in judgment according to the statement that “*losses loom much than gains*” see Kahneman and Tversky (1979, page 279). Another possible motivation can be blamed to the “*de-escalation effect*” that typically occurs when the task is perceived extremely difficult (see Lee et al., 2014).

d) Underconfidence detected in case d) can be explained by the “*de-escalation effect*”, as documented by Lee et al. (2014). An easy-perceived task may reduce the “goal attainment” and consequently cause a disaffection in achieving the goal.

## **5. Summary and Conclusions**

This paper is a part of the growing literature on the impact of behavioral biases on entrepreneurial decision-making process (see Shepherd et al., 2015). Specifically, we focus on the optimism and overconfidence biases. We contribute to the literature in various ways.

First, we introduce a formal definition for optimism, as the tendency to underestimate the difficulty of the task to achieve, then we define overconfidence, as the tendency to overestimate the probability of meeting the commitments. Second, we identify a practical method to calculate the subjective probability to achieve a given task. Third, we identify circumstances where inconsistencies in self-confidence arise.

Our results have also practical implications. In fact, being conscious of being normatively influenced by cognitive biases is essential to take mindful decisions.

## **References**

Abadir, KM 2005, The Mean-Median-Mode Inequality: Counterexamples. *Econometric Theory*, Vol. 21, no. 2, pp. 477-482.

- Beccacece, F and Cillo, A 2006, Applying the Benchmarking Procedure: A Decision Criterion of Choice Under Risk?, *Theory and Decision*, Vol. 61, No. 1, pp. 75-91.
- Berhold, M.H. 1973, The use of distribution functions to represent utility functions. *Management Science*, Vol. 19, pp. 825-829.
- Borch, K. 1968, Decision rules depending on the probability of ruin. *Oxford Economic Papers*, 20, pp. 1-10.
- Bordley, R., LiCalzi, M 2000, Decision analysis using targets instead of utility functions. *Decisions in Economics and Finance*, Springer-Verlag 23, pp. 53-74.
- Bordley R, LiCalzi, M and Tibiletti L. 2014, A target-based foundation for the "hard-easy effect" bias, *Working Paper Series* n. 23/2014, October 2014, Università Ca' Foscari Venezia, Italia, ISSN: 2239-2734. Submitted <http://virgo.unive.it/wpideas/storage/2014wp23.pdf>
- Brealy, RA., Myers SC and Allen, F 2006, *Principles of Corporate Finance*, McGraw-Hill Irwin: New York. ISBN 0-07-295723-9
- Castagnoli, E and LiCalzi, M 1996, Expected Utility without Utility, *Theory and Decision*, Vol. 41, No. 3, pp. 281-301.
- Conine, TE 2014, Estimating the Probability of Meeting Financial Commitments: A Behavioral Finance Perspective Based on Business Simulations. *Global Business and Organizational Excellence*, Vol. 33, pp. 6-13.
- Engelen A, Neumann C and Schwens, C 2014, "Of Course I Can": The Effect of CEO Overconfidence on Entrepreneurially Oriented Firms. *Entrepreneurship Theory and Practice*. doi: 10.1111/etap.12099
- Giardini F, Coricelli G and Joffily, M., & Sirigu, A 2008, Overconfidence in Predictions as an Effect of Desirability Bias. In M. Abdellaoui and J.D. Hey (Eds.), *Advances in Decision Making Under Risk and Uncertainty*, Theory and Decision Library C., Vol. 42 (pp. 163-180). Berlin Heidelberg: Springer-Verlag.
- Everett, CR and Fairchild, RJ 2014, A Theory of Entrepreneurial Overconfidence, Effort, and Firm Outcomes, (September 27, 2014). Available at SSRN: <http://ssrn.com/abstract=2502379> or <http://dx.doi.org/10.2139/ssrn.2502379>
- Galasso A. and Simcoe, T 2011, CEO overconfidence and innovation, *Management Science*, Vol. 57, No. 8, pp. 1469-1484.
- Heath C, Larrick, R and Wu G 1999,. Goals as Reference Points. *Cognitive Psychology*, 38, pp. 79-109.
- Higgins ET 1998, Promotion and prevention: regulatory focus as a motivational principle, in Zanna, M.P. (Ed.), *Advances in Experimental Social Psychology*, Vol.30, Academic Press, New York, NY, pp.1-46.

- Higgins ET, Friedman RS, Harlow, RE, Idson LC, Ayduk ON and Taylor, A 2001, Achievement orientations from subjective histories of success: Promotion pride versus prevention pride, *European Journal of Social Psychology*, Vol. 31, pp. 3-23.
- Hmieleski KM and Baron, RA 2009, Entrepreneurs' optimism and new venture performance: A social cognitive perspective, *Academy of Management Journal*, Vol. 52, No. 3, pp. 473-488.
- Hoffmann AOI, Henry SF, and Kalogeras, N 2013, Aspirations as Reference Points: An Experimental Investigation of Risk Behavior over Time, *Theory and Decision*, Vol. 75, 193-210.
- Kahneman D, Tversky, A 1977, Intuitive Prediction: Biases and Corrective Procedures, Technical rept. 1042-77-6, Decisions And Designs Inc Mclean Va.
- Kahneman D, and Tversky, A 1979, Prospect Theory: An Analysis of Decisions Under Risk. *Econometrica*, Vol. 47, No. 2, pp. 263-91.
- Lee JS, Keil M and Wong, KFE 2014, The Effect of Goal Difficulty on Escalation of Commitment. *Journal of Behavioral Decision Making*, DOI: 10.1002/bdm.1835
- Lichtenstein, S and Fischhoff, B 1977, Do those who know more also know more about how much they know?, *Organizational Behavior and Human Performance*, Vol. 20, pp. 159-183.
- Lichtenstein S, Fischhoff B, and Phillips, LD 1982, Calibration of subjective probabilities: The state of the art up to 1980. In D. Kahneman, P. Slovic, and A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases* (pp. 306-334). New York: Cambridge University Press.
- Modigliani, F and Miller, M 1958, The Cost of Capital, Corporation Finance and the Theory of Investment, *American Economic Review*, Vol. 48, No. 3, pp. 261-297.
- Moore, DA and Healy, PJ 2008, The Trouble with Overconfidence. *Psychological Review*, Vol. 115, No. 2, pp. 502-517.
- Lee JS, Keil M and Wong KFE 2014, The Effect of Goal Difficulty on Escalation of Commitment, *Journal of Behavioral Decision Making*, DOI: 10.1002/bdm.1835
- Savage, LJ 1954, *The foundations of statistics*, New York: Wiley.
- Scheier MF, Carver CS and Bridges, MW 1994, Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the life orientation test, *Journal of Personality and Social Psychology*, Vol. 67 No. 6, p. 1063.
- Shepherd DA, Williams TA and Patzelt, H 2015, Thinking about entrepreneurial decision making: Review and Research agenda, Accepted for *Journal of Management* special review issue.

Staw BM 1976, Knee-deep in the Big Muddy: A Study of Escalating Commitment to a Chosen Course of Action, *Organizational Behavior and Human Performance* Vol. 16, No. 1, pp. 27-44.

Trevelyan, R 2008, Optimism, overconfidence and entrepreneurial activity, *Management Decision*, Vol. 46, No. 7, pp. 986-1001.

Trevelyan, R 2011, Self-regulation and effort in entrepreneurial tasks, *International Journal of Entrepreneurial Behaviour & Research*, Vol. 17, No 1, pp. 39-63.

DOI <http://dx.doi.org/10.1108/13552551111107507>

Yates, JF 1990, *Judgment and decision making*, Englewood Cliffs, NJ, Prentice Hall.

von Neumann, J and Morgenstern, O 1947, *Theory of games and economic behavior*. Princeton University Press, Princeton, Second Edition.

Zwet, WR van 1979, Mean, median, mode II, *Statistica Neerlandica*, Vol. 33, pp. 1-5.